Nancy Heimann
Founder & President
Enginuity Worldwide LLC

Enginuity Worldwide LLC

- Patent Portfolio in Engineered Fuel
- HQ at Missouri Plant Science Center
- Multi-Disciplined Technology Development Team

From a Garage to the World ...

enginuity worldwide

Novel Non-Woody Biomass Conversion Technology Method Deploying Low Energy Roasting & Binder to Produce a Weatherable/High BTU Power Cube™

Conservation of Energy without Fossil Fuels -
What took nature 100 million years, we can now do in 90 days.

Binder

The Enginuity novel, low-cost organic/inorganic binder system provides both improved weatherability and superior durability qualities to non-woody biomass power cubes.

Power Cube™

The patented, stylized corn kernel neither binds nor bridges throughout transportation or material handling. It is important for materials to flow through already existent material handling processes to reduce the barriers for usage of renewable fuels in existing coal fired power plants.

Roaster

The rotary biomass dryer is based on a novel barrel/screw design that compresses material. The heat of compression causes both unbound and bound water to turn to steam, effectively steam drying within the barrel. No energy sources required other than a motor to rotate the rotary biomass screw. Roasting biomass improves energy/content as well as weatherability.

Value Proposition: Dispatchable and Renewable Power Generation

- **TECHNOLOGY for FUEL PRODUCTION – Lower Costs Opportunity:**
  - Enables use of **multiple feedstocks** including woody and annually renewables like grass, and corn stover. This insures an **abundant and competitively sourced supply**.
  - **Engineers a fuel solution** to optimize heat value for boiler efficiency, increase bulk density and durability for lowest cost shipping logistics, manage CO_2, and protect boiler/SCR.
    - Use carbon negative agricultural waste to reduce cost and better meet CO_2 targets
    - Uses woody materials to protect boiler and SCR
  - Enables the **lowest cost alternative fuel** to meet renewable energy and Green House Gas (GHG) targets.
    - Low cost of raw materials—diverse supply of agricultural waste and woody biomass
    - Lowest cost of conversion to fuel
- **JOBS from Home-Grown Energy Harvesting in Missouri – eCARB™ Fuel**
  - Environmentally Continuous Annually Renewable Biomass (eCARB™) fuel product based on Missouri biomass.
  - eCARB™ fuel enables you to **achieve CO_2 and renewable energy objectives** at existing dispatchable power stations **without spending capital to modify your feed or boiler system.** It is a **"drop-in" supplement.**
    - The fuel can have a **carbon negative footprint** due to avoided emission from raw biomass ordinarily left to decompose.
  - Annually Renewable Energy Development District (AREDD™) used to achieve utility scale.
    - Each AREDD™ district sized to allow for potential for producing 1,000,000 tons of biomass fuel, enabling 15 new facilities (equivalent), with approximately $150 million in annual bioeconomy impact.

Missouri State Energy Plan – Electric Generation

October 30, 2014

Biomass Power Production
Issues and Policies
Missouri Power Production

Topics for Today

- Current State of Biomass and Current Policies
- Factors in Missouri and Nationwide
  - Cost Factors
  - Regulatory Factors
- Economic Impact of Home-Grown BioPower
- Recommended Policies

Why Biomass for Power Generation?

- Biomass is grown in every state, every country, every year, and represents a carbon-neutral, on-demand, source of BTU's above the ground.
  - The highest concentration of US biomass potential is in the Midwest.
- Biomass has been integrated into multiple global energy portfolios.
- Biomass (co-fire with coal) represents the lowest cost source of dispatchable, renewable power generation.
- Biomass enables Home-Grown Energy and brings energy independence and home-grown jobs.

However, in US, biomass has been largely ignored in favor of other fuel sources.

Current Biomass Policies in Missouri

- Biomass is an Agricultural Initiative – Biomass Policy is Ag-Based
  - Missouri Department of Ag MASBDA
  - USDA REAP
  - USDA BCAP
- Transition to Power/Energy Discussion is slowly merging
  - Liquid BioFuel Blazed the Trail
  - Discussion Opening for Solid Fuel Biomass for Baseload and Dispatchable Renewable Power Generation

- Questions to Address before Fuel Switch for Power Generation
  - **Scale**
    - Can we reach utility scale? – Will farmers/foresters reliably harvest biomass?
    - Can we harvest in a sustainable way? – Can we protect soil and water assets?
  - **Cost**
    - Can we generate baseload biomass power to complement with legacy power generation?
  - **Engineering**
    - Can we engineer fuel characteristics to keep power station operating efficiently?

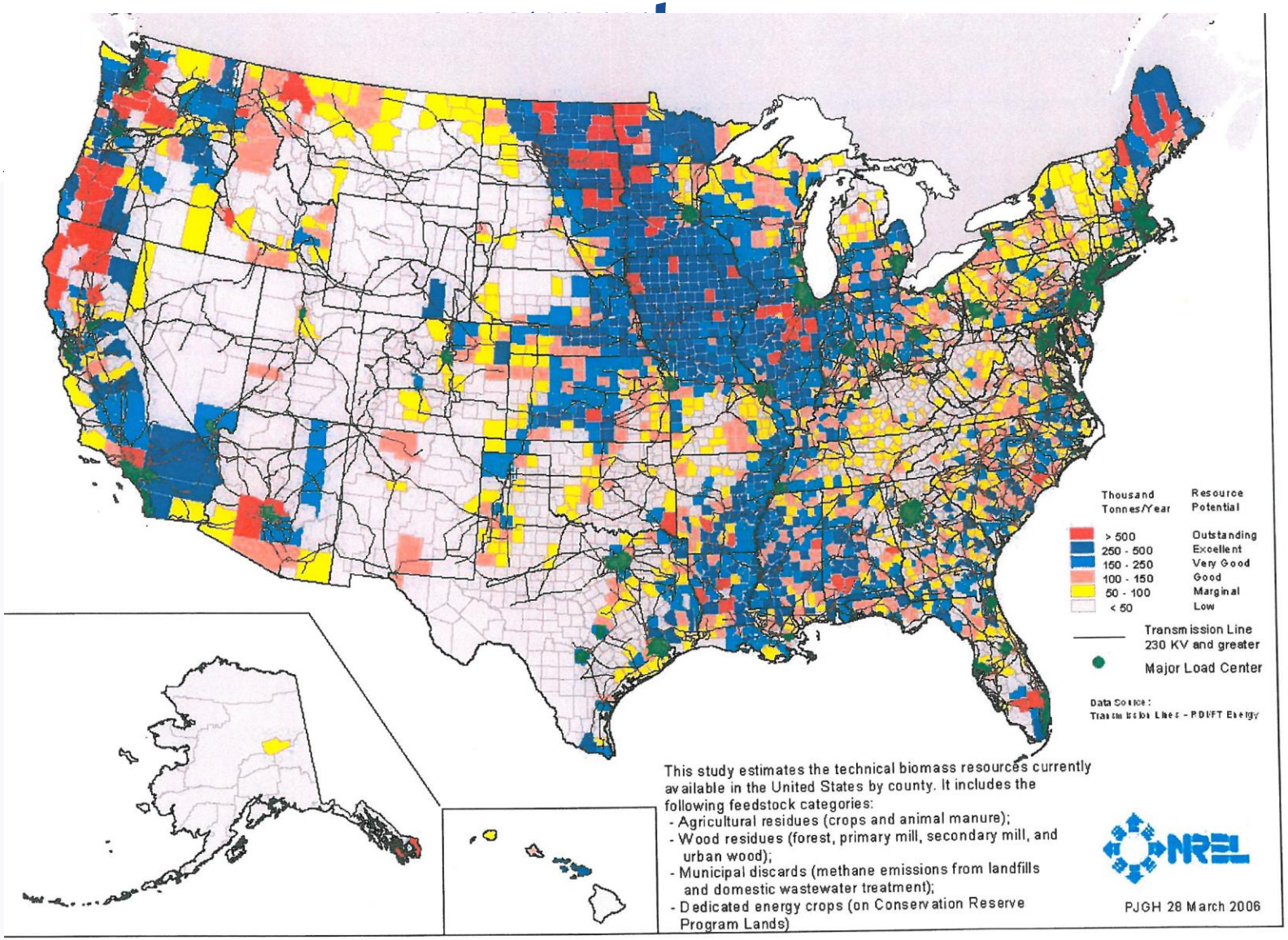

Figure 13.1. Biomass Resources, Transmission, and Load Centers

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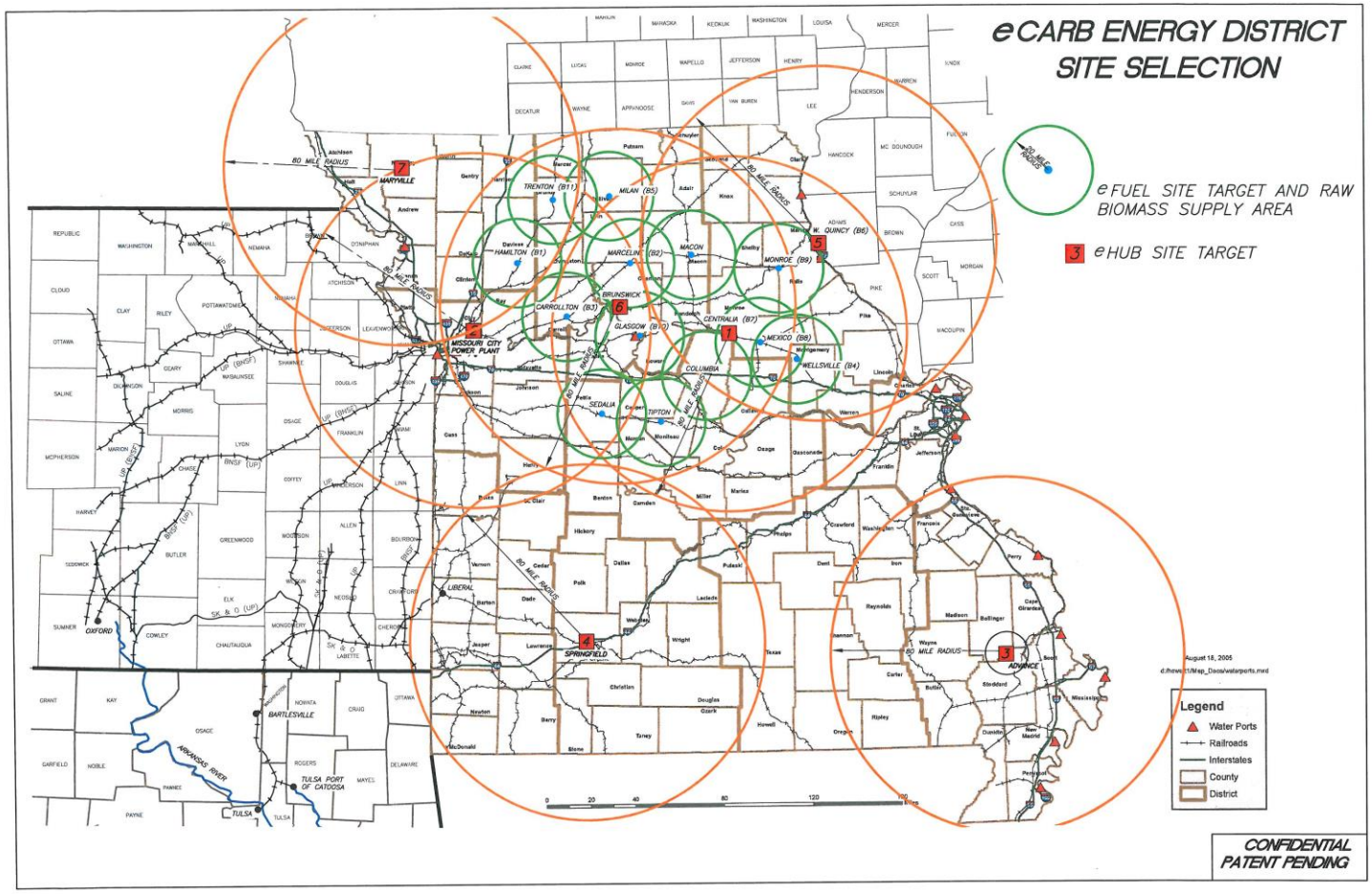
Utility Scale Supply



Current Power Generation Profile (Missouri & Friends)
Year 2013 – x 1,000 MW-hr

State	TOTAL POWER GENERATION	COAL	WIND	SOLAR	BIOMASS
Missouri	91,983	76,345 (83%)	1,168 (1%)	--	62 (0.1%)
Iowa	54,447	31,320 (57%)	15,569 (29%)	--	114 (0.2%)
Illinois	199,799	86,203 (43%)	9,607 (5%)	64 (0.04%)	628 (0.3%)
Texas	392,179	149,404 (38%)	35,937 (9%)	173 (0.04%)	641 (0.2%)

Reference: US Energy Information Administration 2013 Power Report – Electricity Data Browse – Net Generation Data Set
http://www.eia.gov/electricity/data/browser/

Current Power Prices (Missouri & Friends) cents/hw-hr

State	Average Retail	Industrial Customer (8/14)
Missouri	8.53	7.37
Iowa	7.71	7.15
Illinois	8.40	6.38
Texas	8.55	6.34

Reference: US Energy Information Administration 2013 Power Report

Cost of Power Generation (Traditional Sources) cents/hw-hr

Generation	Average Power Plant Operating* Expenses in IOU Power Plants (2012 Data)
Nuclear	2.55
Fossil Steam (Coal-Fired)	3.19
Hydroelectric	1.13
Gas Turbine	3.57

*Does not include capital expenses or depreciation.

Reference: US Energy Information Administration Power Report Table 8.4
Source of Data: Federal Energy Regulatory Commission, FERC Form 1, "Annual Report Major Electric Utilities, Licensees and Others via Ventyx Global Energy Velocity Suite

CAA 111d – US EPA Regulatory Approach for Reducing CO_2 Emissions from Power

- 30% Reduction in Green House Gas (GHG) by 2020
  - Missouri target is 21%
- States will Regulate within EPA Guidance
- Some Coal Utilities Opinion is 111d is "election-proof"

- Biomass was referenced in CAA 111d Proposal
  - "Because of the positive attributes of certain biomass-derived fuels, the EPA also recognizes that biomass-derived fuels can play an important role in CO_2 emission reduction strategies."

REFERENCE: USEPA Clean Power Plan 79 *FR* 34829; Page: 34829 -34958

Lowest Cost Alternatives for Dispatchable Baseload In Compliance with CAA 111d (21% GHG Reduction Target)

Technology	Assumptions	Cost of Power Production Cents/kw-hr	Expected Price Trend	Capital Included?
Coal	$3/MMBTU, 10 Heat Rate	3.19 cents Range 3 to 3.3 cents	Lower	Yes
Natural Gas	$4 and $6 ($8)/MMBTU, Heat Rate 8,	3.5 cents Range 3.2 to 4.8 cents (6.4 cents)	Volatile	No--$1.0 mil/MW
Coal With Carbon Credits	1 MW-hr coal emission is 1.8 tons/CO2 Equiv, $14/ton credit	5.0 cents	Higher	N/A
Coal with Sequestration	Heat Rate de-rated by 20% on 10 Heat Rate Plant	6.2 to 7.7 cents	Stable	Yes
Wood Chips/Pellets	10 Heat Rate Power Plant – 35-50% MC	5.0 to 7.0 cents	Site specific	No--$1.5-2.0 mil/MW
Engineered Biomass Fuel **eCARB™**	10 Heat Rate Power Plant $4-6/MMBTU for eCARB™ fuel	4.0 to 6.0 cents	Stable	Yes
Recommended Approach for 111d	**20% Co-Fire, 10 Heat Rate Plant $4-6/MMBTU for eCARB™ fuel, $3/MMBTU for coal**	**3.2 to 3.6 cents**	**Stable**	**Yes**

Reference: US Energy Information Administration Power Report Table 8.4
Interviews with Power Plant Operators

Engineering Opportunity: Dispatchable and Renewable Power Generation

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  - Annually Renewable Energy Development District (AREDD™) used to achieve utility scale
    - Potential for producing 1,000,000 tons of biomass fuel, enabling 15 new facilities (equivalent), with

Economic Development Potential:

Building Fuel Plants in Missouri

PASTURE

- Corn Stover
- CRP Grass
- Energy Crops
- Landfill Diversion

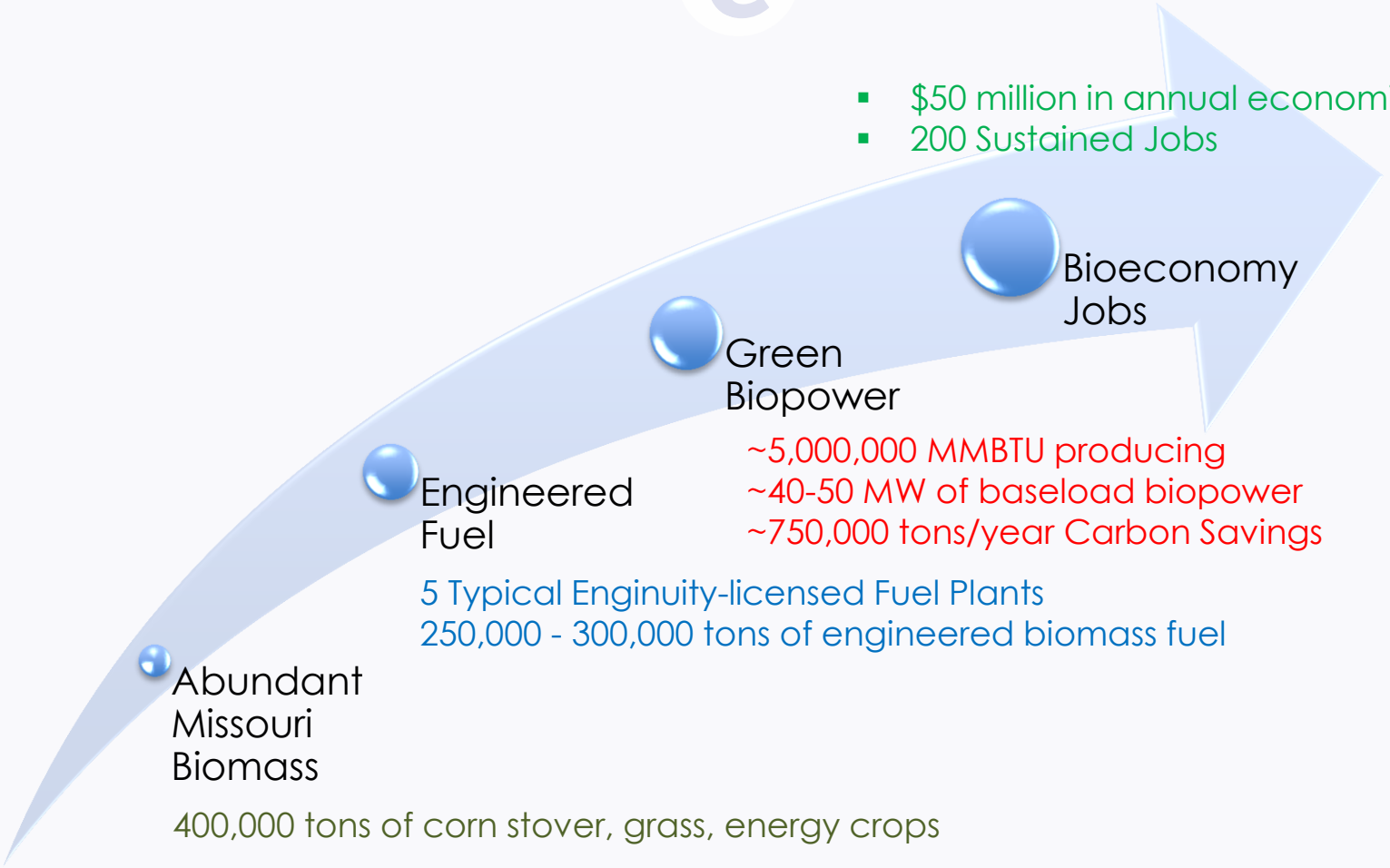
Fuel Plants make eCarb™

- Durable
- Dense
- Weather Resistant
- Free Flowing

POWER

- Co-Fire with Coal
- Repower
- Carbon-Free RFP

BUILDCO 1 – Building Biomass Fuel Production Facilities – Modeled 300,000 ton capacity in 5 Plant Build-Out



REFERENCE: University of Missouri Extension - Commercial Agriculture Program

Future Generation Profile
Year 2013 Baseline with 15% Co-Fire Modeled

	TOTAL POWER GENERATION	COAL	BIOMASS Power	Sustained Jobs from Biopower (Based on MIZZOU Implan Analysis of eCARB™ plants)	Economic Activity (Based on MIZZOU Implan Analysis of eCARB™ plants)	CO_2 Reduction from Baseline (Carbon Footprint is Function of the Incoming Raw Biomass Sources Used)
	in 1,000's kw-hr					
Missouri Current 2013	91,983	76,345 (83%)	62 (0.1%)			
Missouri w/ 15% Co-Fire of Biomass Fuels	91,983	64,893 (71%)	11,452 (12%)	**4,800 new bioenergy jobs**	**$1.2 billion annual economic activity**	**10-13% woody biomass 11-14% energy crops 18-20% eCARB™ Fuel**

Reference: US Energy Information Administration 2013 Power Report
National Renewable Energy Labs – Life Cycle / Carbon Cycle Methodology
University of Missouri Extension - Commercial Agriculture Program

Call for Action – Recommended Biomass Policies in Missouri

- **Explicitly include biomass and biomass co-firing as a component of the Missouri State Energy Plan.** This clarity is essential, given that to date biomass co-firing has not been included in many federal or state renewable initiatives.
  - Call for solid biofuel symposium to explore and collaborate cost effective biomass-based dispatchable renewable power.

- **Level the Playing Field:** Place solid biomass fuel on par with other renewable energy sources as a priority by utilizing:
  - Incentivization, grants, tax credits
  - Research and development
  - Logistical Support

- **Promote Home-Grown Energy and Home-Grown Jobs:** Based on the cost-effective power generation available through biomass co-fire, and the positive economic development outcomes possible, develop a set-aside in the state renewable energy portfolio requirements for all utilities to include 5% in-state generated biomass power.
  - 1,000,000 ton biomass district (AREDD) projected to yield 600 jobs and $150 million in annual bioeconomy activity.

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